

The Henderson Mine as an Underground Laboratory

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University of Colorado

for the Henderson Underground Science and
Engineering Project (HUSEP) Collaboration

BNL-FNAL Neutrino Study

FNAL, June 28, 2006

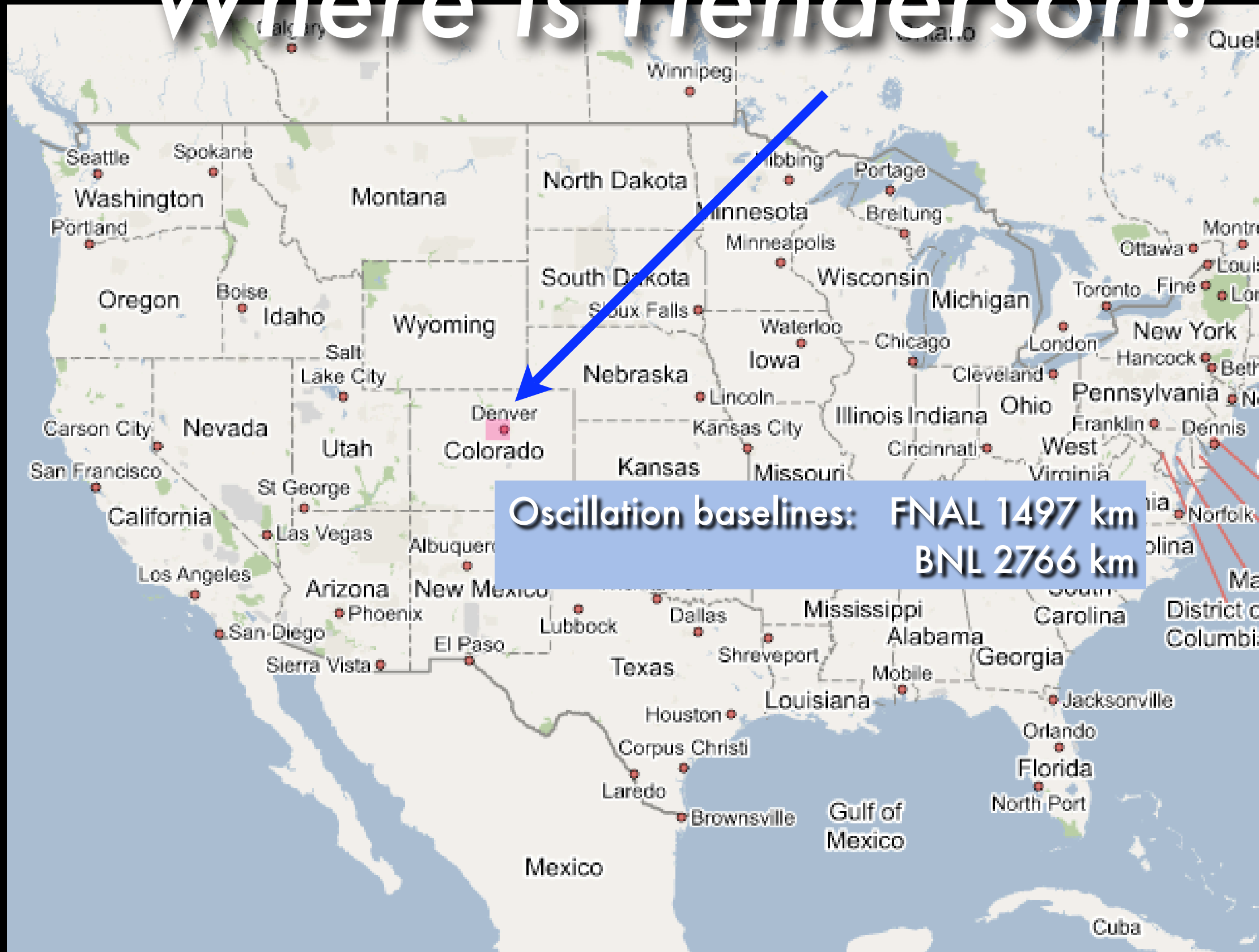
The Henderson Mine as an Underground Laboratory

- The Henderson Mine
 - Location, history, existing facilities
- Proposed laboratory construction
- Scientific opportunities
- Organization and workshop schedule

The Henderson Mine

- High-volume mine on world's second largest known molybdenum deposit
- Owned and operated by Climax Molybdenum Co., subsidiary of Phelps Dodge
- Mine was built in the 1970s, extensively modernized in late 1990s.

Where is Henderson?



Where is Henderson?

Here!



330 LOS ALAMOS

19 WINTER PARK

DENVER

BOULDER

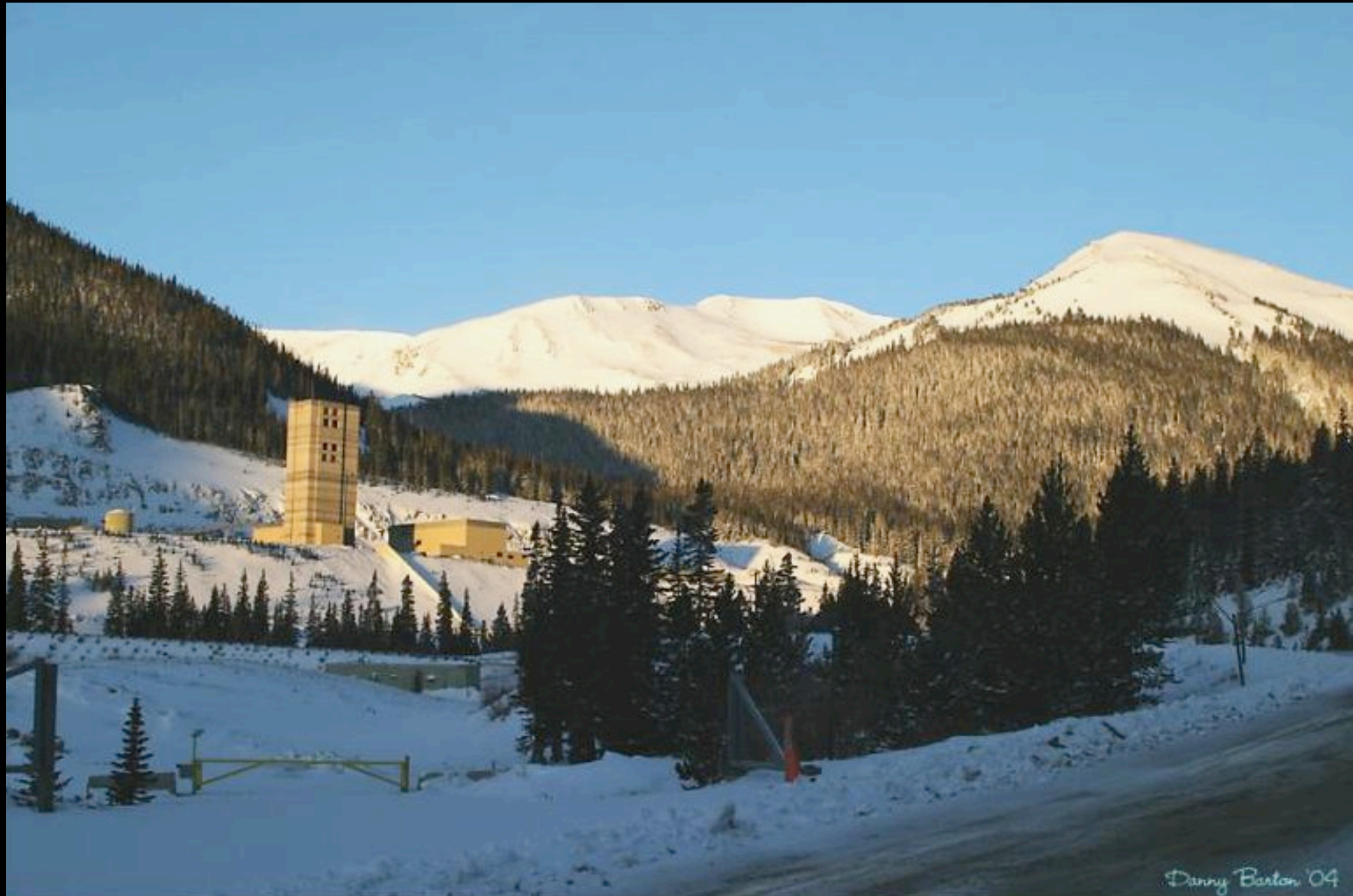
DENVER INT'L AIRPORT

50

55

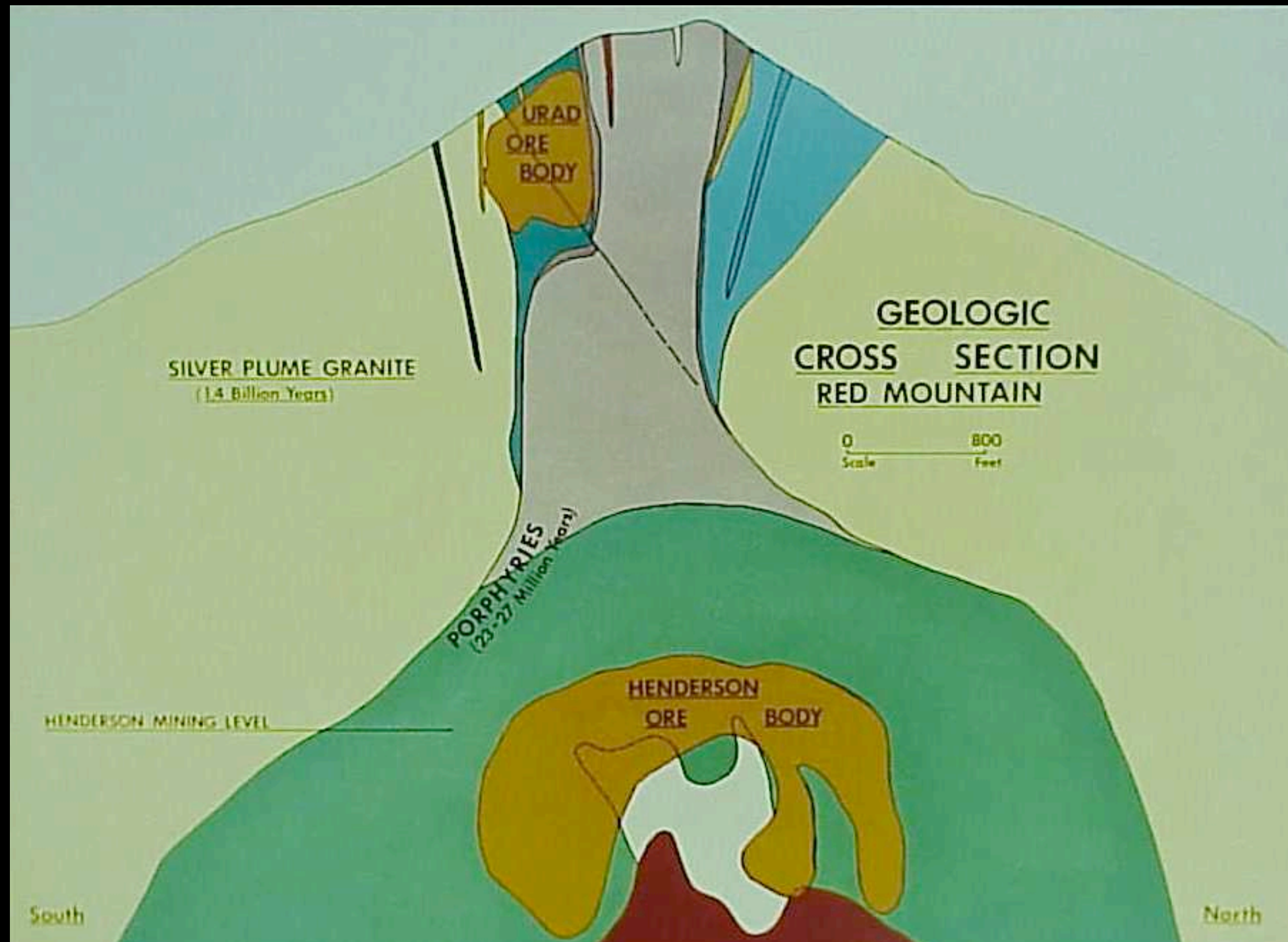
70

The Mine Site

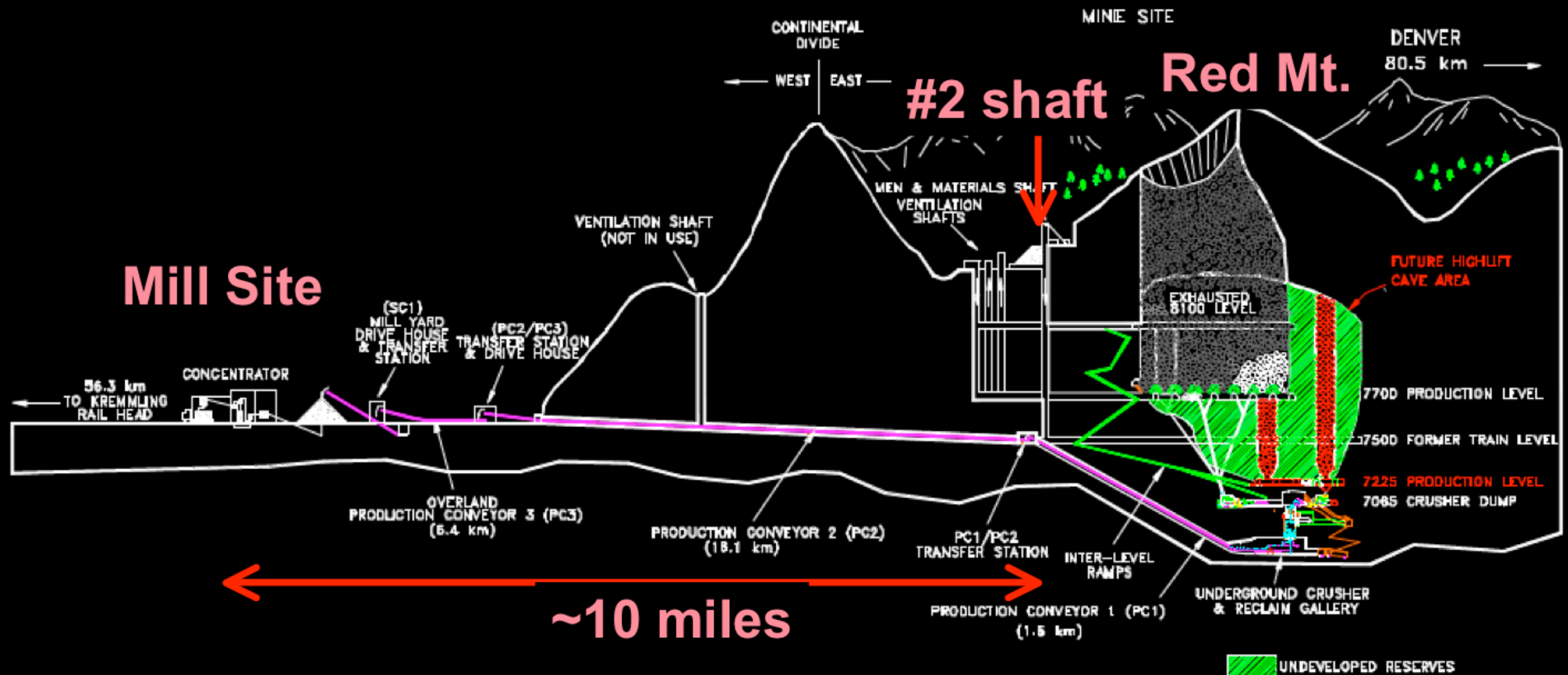


Danny Barton '04

The Geology



The existing mine



- Underground crusher processes 80 tons in seconds
- Rock dropped onto high-speed conveyor to tailings site

Existing mine facilities

- Access drifts accomodate six-seat vehicles
- Excavation Capacity: ~40,000 - 50,000 ton/day: Equivalent of the Super-K cavern every four days.
 - Actual operation: ~20,000 - 30,000 ton/day: under-utilized capacity
- 10 mile tunnel with high speed conveyor to tailings site
 - Conveyor belt: 50kton/day max capacity, 20kton/day normal operation
- Moderate temperature - cool air available year round
- High capacity water and sewage treatment plant
- Electric power station: 2 x 24 MW — also underutilized
- Tailings site owned by mine company
 - existing permit allows the deposition of over 340Mton. No new environmental permits required.
- Large office building and warehouses; space for more surface buildings adjacent to existing ones — could build a real surface campus (State of Colorado support)
- Anticipated mine closing in about 20 years
 - Mine Co. and local politicians see science as one possible way of retaining employment, revitalizing the area, etc

Engine room



- 28-foot shaft can accommodate:
 - 200 people with 5-minute trip between surface (10,500) and 7500-foot level
 - 50 ton load
 - Standard shipping container

Feeding the rock crusher



Feeding the rock crusher



Feeding the rock crusher



Feeding the rock crusher



The crusher crushes



The crusher crushes



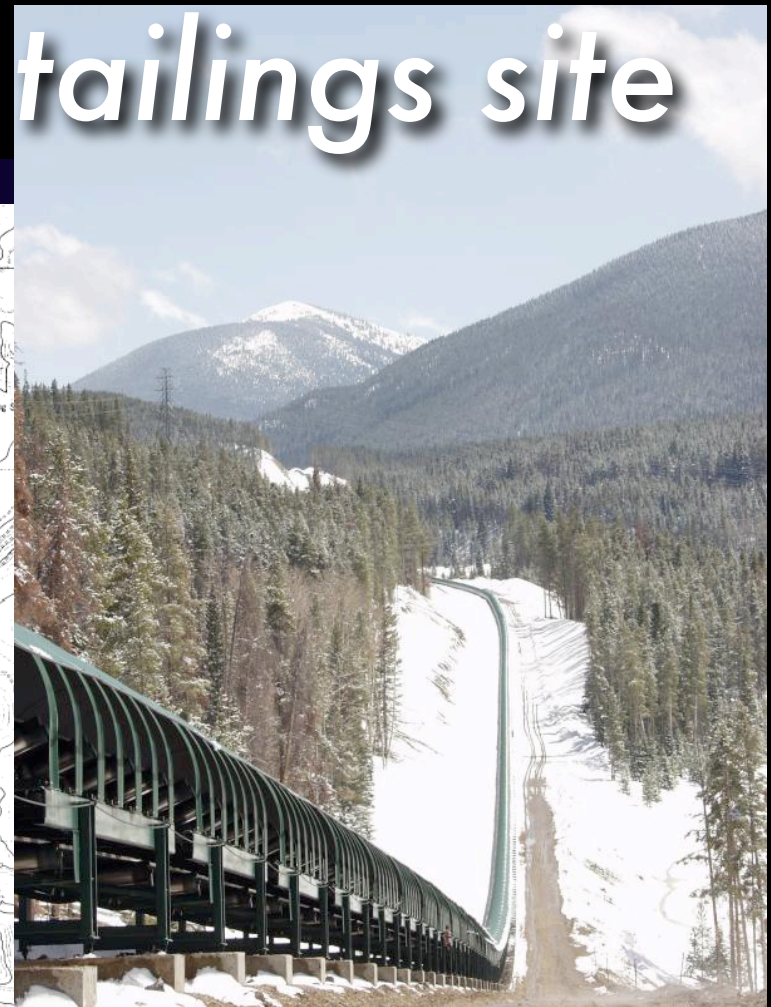
The crusher crushes



Rock from crusher on the high-speed conveyor



Conveyor takes rock under Continental Divide to tailings site

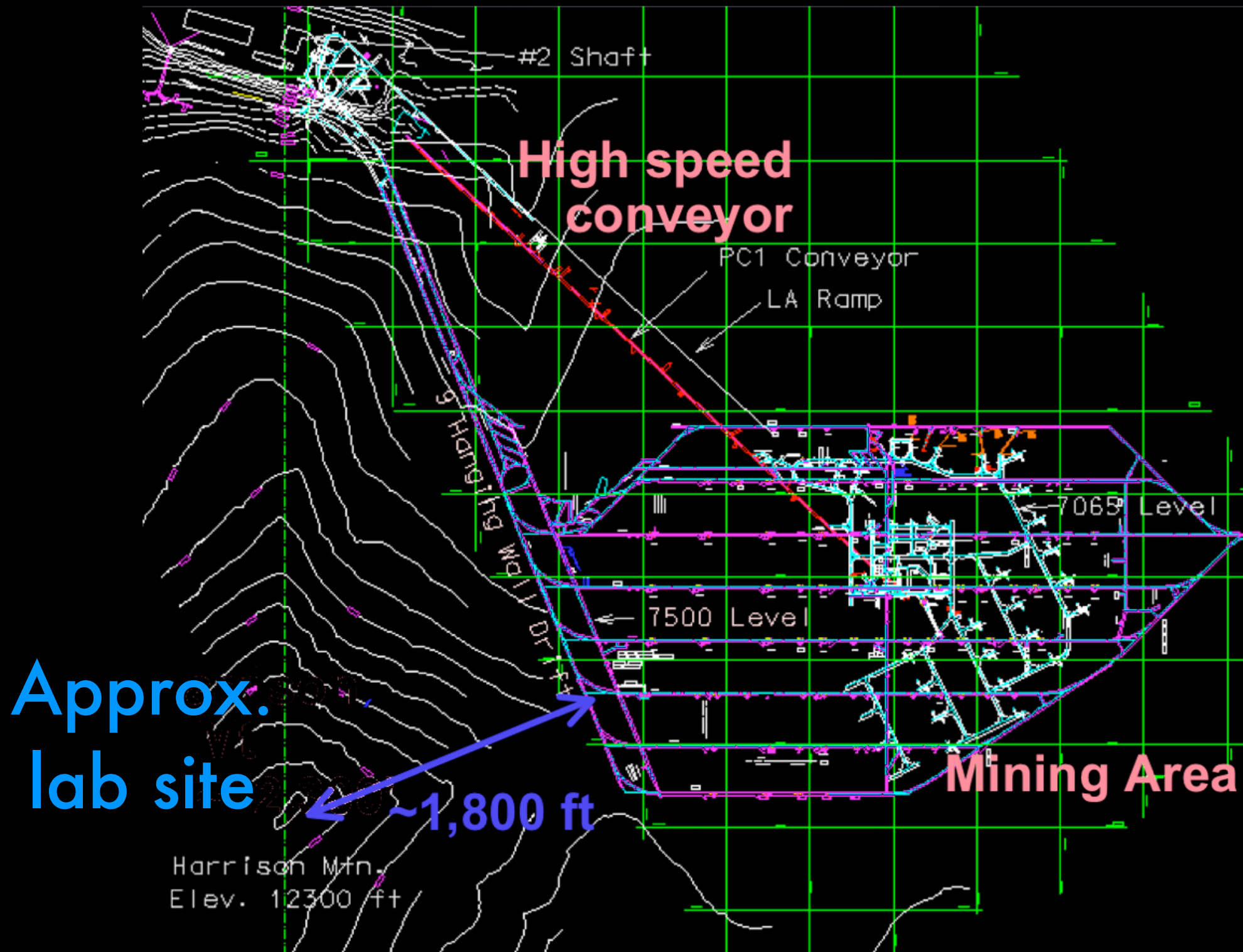


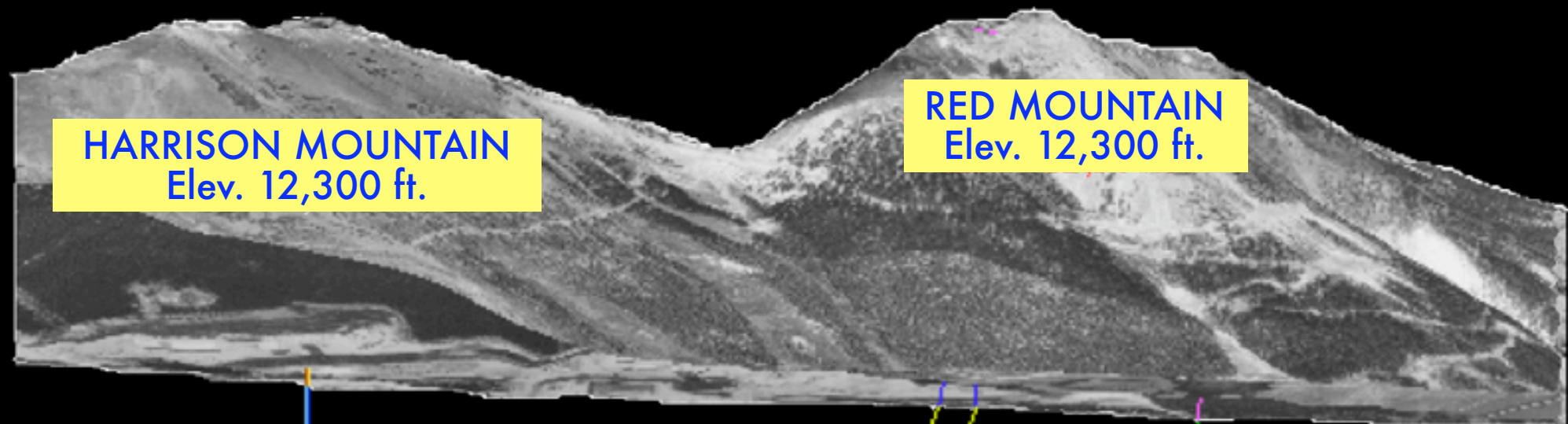
**MAIN
HENDERSON
PROPERTY**

**HIGH-SPEED
CONVEYOR:
10 MILES**

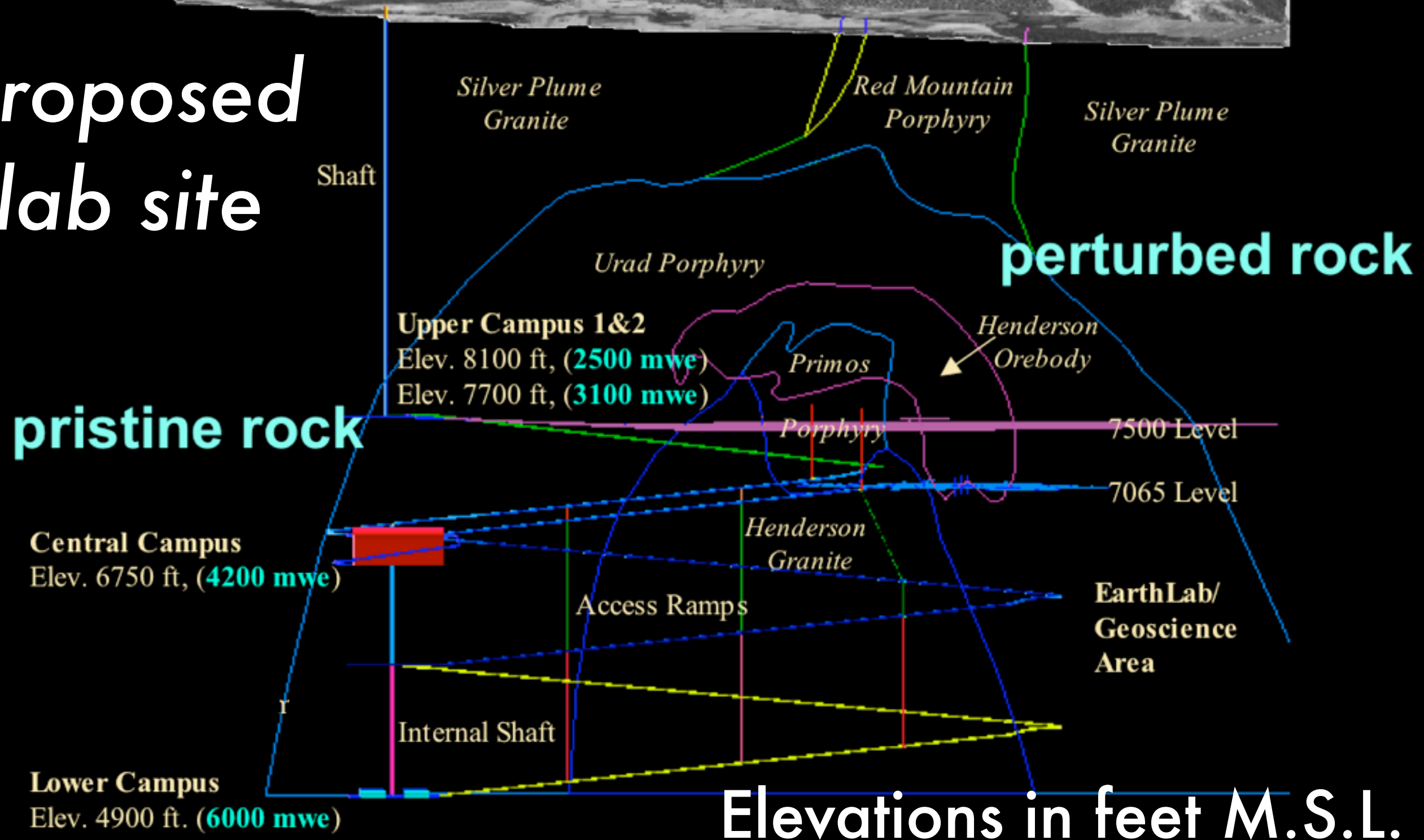
**CONVEYOR
TUNNEL COULD
PROVIDE
HORIZONTAL
ACCESS AFTER
MINING ENDS**

Existing infrastructure and lab site: plan view





Proposed lab site



Upper Campus

- (8100 level, 2500 mwe) is a 32,000 ft² former machine shop with crane access. Could be ready for prototypes/small experiments within months, at cost of about \$100K.



- 7700 level (3000 mwe) will be developed as a full experimental area, with several 20m caverns. These would be outfitted within a year of construction start.

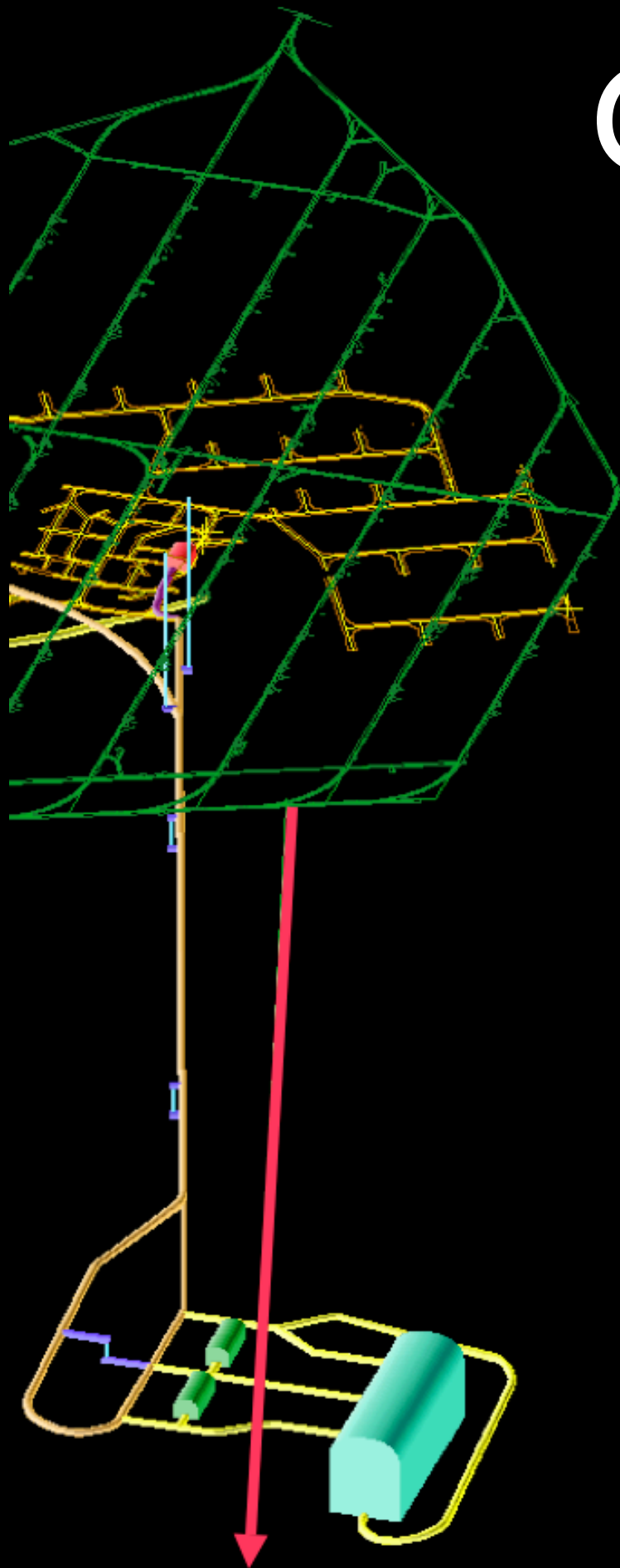
Central Campus

- Second area of lab development: ~1 year to access, plus 1.5 years for construction, outfitting.
- Elevation 6750 ft (4200 mwe) level, accessed by new ramps from existing shaft area
- Central campus will have several large, multipurpose caverns (~20x20x100 m³)

Central Campus

- Also natural location for future megaton-scale proton decay/neutrino detector cavern (shown in diagrams, but not part of DUSEL scope)
- Location allows construction to take place at any future time without significant impact on personnel access or existing experiments.
- Construction layout is maximally flexible: experimental program needs and schedule will dictate the balance of development between Central and Upper campuses.

Core drill to Central Campus site

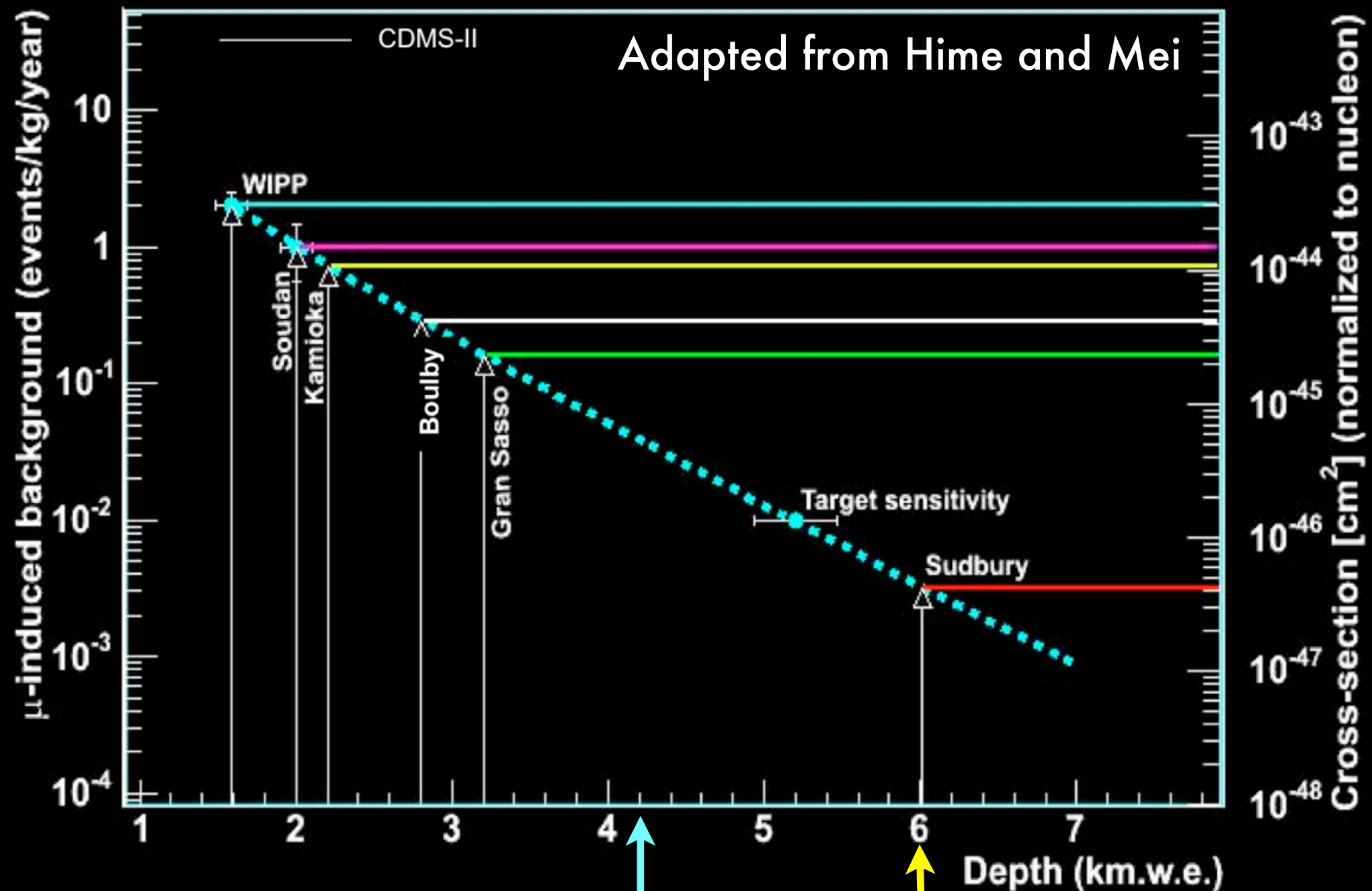


- State of Colorado and participating universities funded an exploratory core drill to the proposed central campus site in 2004.
- 750 m long, inclination of 26 degrees, from top at 7,500' MSL to bottom at 6,300' (past Central Campus site)
- Results (good news):
 - Extremely competent Urad Porphyry (Granite)
 - Very hard with a high percentage of quartz.
 - Expected to have high compressive strength
 - No evidence of mineralization
 - Good news! Climax won't want to mine here.
 - No problem foreseen for constructing DUSEL

Lower Campus

- Final area of lab development: ~5 years
- Elevation 4900 ft (6000 mwe), for lowest-background requirements
- Typical lower campus cavern size
~20x20x50 m³
- Likely location for future phase of double-beta, dark matter, solar neutrino experiments
- Second core drill to lower campus site completed this month.

Dark matter sensitivity

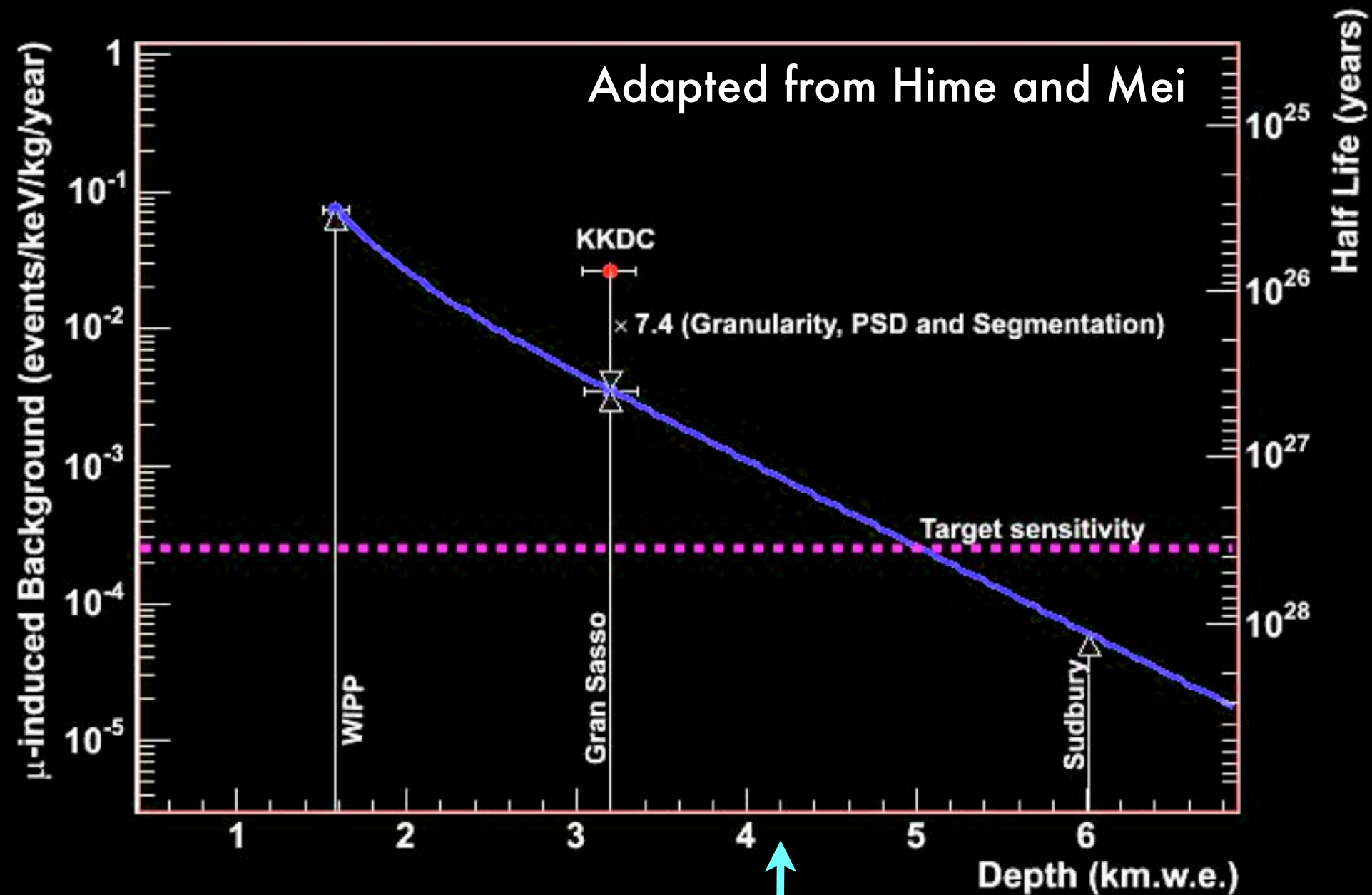


Central Campus

Lower Campus

Henderson

Neutrinoless double beta decay sensitivity



Central Campus

Lower Campus

Henderson

Henderson Lab organization

- Henderson Underground Science and Engineering Project (**HUSEP**) Collaboration
Spokesperson: C. K. Jung, Deputy Spokesperson: R. J. Wilson
 - The Arapaho Project (local community group)
 - Climax Molybdenum Company
 - Colorado School of Mines
 - Colorado State University
 - State University of New York at Stony Brook
 - University of Colorado at Boulder
- State of Colorado commission formed by Gov. Owens in October

State Support

- Already spent: 300K for core drilling to Central Campus site (in 2005) and Lower Campus site (in 2006).
- Colorado Senate Bill 06-229: State will provide \$20M for surface facilities (visitors' center, surface lab space, dormitories, cafeteria) contingent on NSF selection of Henderson site. **Signed into law on May 31.**

An Act

SENATE BILL 06-229

BY SENATOR(S) Fitz-Gerald, Igar, Taylor, Boyd, Brophy, Gordon, Groff, Keller, Kester, May R., Mitchell, Owen, Shaffer, Teck, Tochtrop, Tupa, Veiga, Wiens, Williams, Windels, Bacon, and Tapia; also REPRESENTATIVE(S) Plant, Berens, Crane, Harvey, Hodge, Jahm, Kerr A., Kerr J., Liston, Madden, Marshall, McCluskey, McGihon, Rose, Sullivan, White, and Wirtner.

CONCERNING THE USE OF MONEYS FROM THE OPERATIONAL ACCOUNT OF THE SEVERANCE TAX TRUST FUND TO PAY FOR THE STATE'S SHARE OF A FACILITY RELATED TO A NATIONAL DEEP UNDERGROUND SCIENCE AND ENGINEERING LABORATORY TO BE LOCATED IN THE STATE.

Be it enacted by the General Assembly of the State of Colorado:

SECTION 1. Legislative declaration. (1) The general assembly hereby finds and declares that:

(a) The national science foundation is in the final stages of selecting the site for the development of a national deep underground science and engineering laboratory (DUSEL) to be used for advanced experiments in physics, geosciences, and biosciences.

(b) The purpose of a DUSEL is to enable the broad range of science

(D) FIVE MILLION DOLLARS FOR THE STATE FISCAL YEAR COMMENCING JULY 1, 2010; AND

(E) FOUR MILLION DOLLARS FOR THE STATE FISCAL YEAR COMMENCING JULY 1, 2011.

(IV) IF THE NATIONAL SCIENCE FOUNDATION DOES NOT AWARD THE DUSEL TO THE HENDERSON MINE NEAR EMPIRE, THE GENERAL ASSEMBLY SHALL NOT APPROPRIATE MONEYS PURSUANT TO THIS PARAGRAPH (I). IN ADDITION, THE GENERAL ASSEMBLY SHALL ONLY APPROPRIATE MONEYS PURSUANT TO THIS PARAGRAPH (I) FOR A GIVEN STATE FISCAL YEAR, IF, BASED ON THE PRECEDING MARCH REVENUE FORECAST FROM THE LEGISLATIVE COUNCIL, THERE WILL BE SUFFICIENT REVENUE IN THE OPERATIONAL ACCOUNT OF THE SEVERANCE TAX TRUST FUND AFTER ALL THE APPROPRIATIONS AUTHORIZED OR REQUIRED BY LAW AS OF THE MARCH REVENUE FORECAST TO MEET THE YEAR END BALANCE FOR THE GIVEN STATE FISCAL YEAR THAT IS REQUIRED PURSUANT TO SUBPARAGRAPH (III) OF PARAGRAPH (c) OF SUBSECTION (1) OF THIS SECTION AND REQUIRED PURSUANT TO SUBPARAGRAPH (I) OF PARAGRAPH (F) OF SUBSECTION (1.5) OF THIS SECTION.

(V) THE APPROPRIATIONS PURSUANT TO THIS PARAGRAPH (I) SHALL BE EXEMPT FROM THE REQUIREMENTS OF SUBPARAGRAPH (III) OF PARAGRAPH (c) OF SUBSECTION (1) OF THIS SECTION.

SECTION 3. Effective date. This act shall take effect at 12:01 a.m. on the day following the expiration of the ninety-day period after final adjournment of the general assembly that is allowed for submitting a referendum petition pursuant to article V, section 1 (3) of the state constitution (August 9, 2006, if adjournment sine die is on May 10, 2006); except that, if a referendum petition is filed against this act or an item, section, or part of this act within such period, then the act, item, section, or

(a) It is strongly in favor of the designation of the Henderson mine site as the preferred site for the proposed DUSEL.

(b) The appropriations required by this act demonstrate the general assembly's intention to work with the federal government and local stakeholders and to provide financial support for the DUSEL at the Henderson mine site.

SECTION 2. 39-29-109 (1), Colorado Revised Statutes, is amended BY THE ADDITION OF A NEW PARAGRAPH to read:

39-29-109. Severance tax trust fund - created - administration - use of moneys - definitions - repeal. (1) (I) (I) AS USED IN THIS PARAGRAPH (I), UNLESS THE CONTEXT OTHERWISE REQUIRES, "DUSEL" MEANS A NATIONAL DEEP UNDERGROUND SCIENCE AND ENGINEERING LABORATORY.

(II) EXCEPT AS OTHERWISE SET FORTH IN SUBPARAGRAPH (IV) OF THIS PARAGRAPH (I), FOR FIVE STATE FISCAL YEARS BEGINNING WITH THE STATE FISCAL YEAR COMMENCING JULY 1, 2007, THE GENERAL ASSEMBLY SHALL APPROPRIATE AN AMOUNT NOT EXCEEDING THE AMOUNTS SET FORTH IN SUBPARAGRAPH (III) OF THIS PARAGRAPH (I) FROM THE OPERATIONAL ACCOUNT OF THE SEVERANCE TAX TRUST FUND TO THE DEPARTMENT OF NATURAL RESOURCES FOR THE PURPOSE OF PAYING THE STATE'S SHARE OF THE COSTS RELATED TO THE CONSTRUCTION AND OPERATION OF A DUSEL FACILITY THAT WILL HOUSE A VISITORS' CENTER, EDUCATIONAL RESOURCES, AND ADMINISTRATIVE OFFICES RELATED TO THE DUSEL.

(III) THE APPROPRIATIONS REQUIRED PURSUANT TO SUBPARAGRAPH (II) OF THIS PARAGRAPH (I) ARE AS FOLLOWS:

(A) ONE MILLION DOLLARS FOR THE STATE FISCAL YEAR COMMENCING JULY 1, 2007;

(B) FIVE MILLION DOLLARS FOR THE STATE FISCAL YEAR COMMENCING JULY 1, 2008;

(C) FIVE MILLION DOLLARS FOR THE STATE FISCAL YEAR COMMENCING JULY 1, 2009;

part, if approved by the people, shall take effect on the date of the official declaration of the vote thereon by proclamation of the governor.

Joan Fitz-Gerald
Joan Fitz-Gerald
PRESIDENT OF
THE SENATE

Andrew Romanoff
Andrew Romanoff
SPEAKER OF THE HOUSE
OF REPRESENTATIVES

Karen Goldmar
Karen Goldmar
SECRETARY OF
THE SENATE

Marilyn Eddins
Marilyn Eddins
CHIEF CLERK OF THE HOUSE
OF REPRESENTATIVES

APPROVED *May 31st, 2006* *1:50 pm*

Janet E. Norton - Acting Governor
Janet E. Norton
GOVERNOR OF THE STATE OF COLORADO

HUSEP Physics Committee

- Chair **Dan Akerib** (CWRU)
- Co-chairs **R. J. Wilkes** (Univ. of Washington), **EDZ**
- Working groups:
 - Neutrino mass (solar, $0\nu\beta\beta$)
 - Convenor: TBA (see me if interested)
 - Neutrino mixing
 - Convenors: **W. Toki**, **C. Lunardini**
 - Dark matter
 - Convenors: **H. Nelson**, **L. Rosenberg**
 - Nucleon decay
 - Convenors: **M. Goodman**, **Tony Mann**
 - Astrophysics
 - Convenors: **A. Habig**, **T. Weiler**

Workshops on Henderson

- November 18-19, 2005 at Colorado State University in Fort Collins
- “Capstone Workshop” May 3-7, 2006 at SUNY-Stony Brook
- Documents and workshop programs/transparencied ara available at <http://ale.physics.sunysb.edu/husep>; Click on “Conferences and Workshops”)